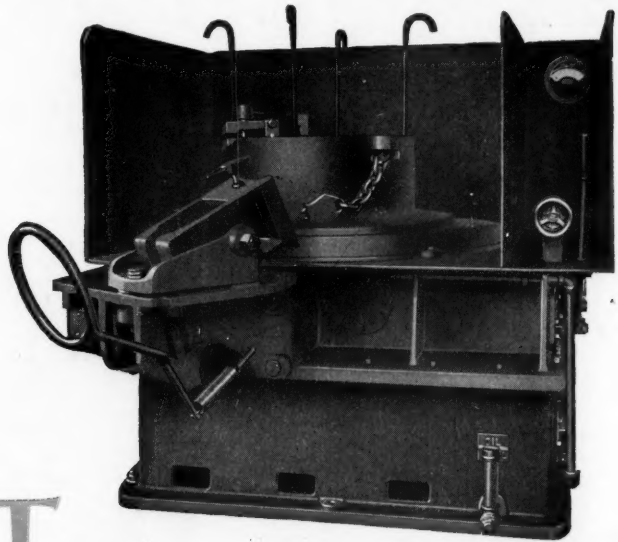
WIRE
& WIRE PRODUCTS

VAUGHN



THERE are enough large size Motoblocs in service now to produce at least 100,000 tons a year of hexagon and round wire averaging ½" diameter. We will be glad to send you the detailed facts.

The Vaughn Machinery Co.

Manufacturers of Vaughn MOTOBLOCS, Continuous Copper Wire Drawing Machines and other wire mill equipment for pointing, cleaning, baking, patenting and heat-treating, galvanizing and tinning, etc.

Cuyahoga Falls, Ohio

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MOTOBLOC

5½ = 4

ONE of the industrial leaders of America recently made the statement "when industry is 100% 'Carboloy-ized' it will do in 4 days what it now takes 5½ days to accomplish".

He was conservative.

Many of the larger wire companies and equally as many smaller mills are now completely tooling their wire drawing machines with Carboloy Dies.

These companies will have a material advantage over their competitors.

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Look for the mark of Carboloy, —if the mark is not on the product it is not a Carboloy cemented tungsten carbide product.

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Speed Production with CARBOLOY

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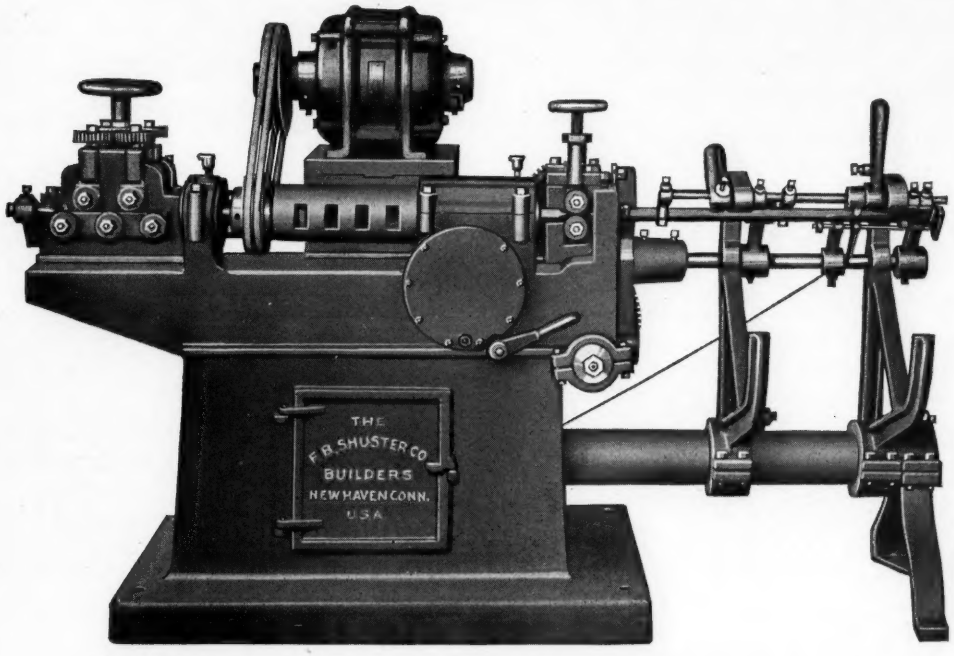
SHUSTER

Automatic Wire Straightening and Cutting Machinery



WE are showing this month a self contained motor driven Machine, equipped with a five roll straightener which rough straightens the stock before it enters the rotary head, and which is a valuable addition on some kinds of wire.

The straightening head is of steel, and mounted in Timken Roller Bearings—Bearings are bronze bushed, etc.

Makes the wire perfectly straight, at high speed, and cuts absolutely accurate lengths day after day for years, with little attention either for operation or maintenance.

Can we tell you more about it?

The F. B. Shuster Co. **New Haven, Conn.**

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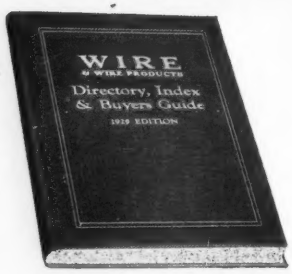

¶ Below is a typical listing from the 1929 Directory

MACHINERY: WIRE DRAWING

AMERICAN INSULATING MACHY. CO., Philadelphia, Pa.
Bates Mfg. Co., Joliet, Ill.
BERNITZ, J. I., 25 Beaver, NYC
Blake & Johnson Co., Waterbury, Conn.
Bliss, E. W., Co., Brooklyn, N. Y.
Broden Construction Co., Cleveland, Ohio
Brown Engine & Machine Co., Fitchburg, Mass.
Burlingame Machine Co., Worcester, Mass.
Farnham Mfg. Co., Buffalo, N. Y.
General Engineering & Supply Co., 160 5th Av., NYC
Humphrey & Sons, Joliet, Ill.
Leiman Bros., 23 Walker, NYC
Mackenzie's, Duncan, Sons Co., Inc., Trenton, N. J.
MORGAN CONSTRUCTION CO., Worcester, Mass.
NATIONAL-HARRIS WIRE CO., Newark, N.J.
New England Wire Machy. Co., New Haven, Conn.
Richard Mfg. Co., Bloomsburg, Pa.
SLEEPER & HARTLEY, Inc., Worcester, Mass.
Somerville, Wm. E., & Co., Coal City, Ill.
Standard Machinery Co., Auburn, R. I.
Superior Tool & Mfg. Co., Worcester, Mass.
TORRINGTON MFG. CO., Torrington, Conn.
Treadwell Engineering Co., Easton, Pa.
Universal Hoisting Machy. Corp., Buffalo, N. Y.
Universal Wire Machy. Co., New Haven, Conn.
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

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THE second annual edition of this Directory is the only reference work of its kind for bare and covered wire makers, fabricators of wire products, and sources of supply for wire and wire forming mill equipment.

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IN his chapter entitled Technical Changes in Manufacturing Industries which is a part of the Report of the Committee on Recent Economic Changes, L. P. Alford says that the attitude of manufacturers toward all types of equipment may be expressed by the following three questions:

Will it improve the quality of our product?

Will it improve our service in filling customers' orders?

Will it reduce costs?

* * *

This analysis of the attitude of the machinery buyer is not new. Yet, coming as a result of a study of present day economics, it is important. It may be taken as a reminder of the fundamentals of machinery selling and, as such, may serve to prevent unnecessary complication of sales operations and technique.

* * *

This chapter of the Report of Recent Economic Changes contains some additional interesting information in connection with machinery sales.

A questionnaire was sent to 800 of the larger and more representative manufacturing concerns in the United States. This questionnaire sought to disclose the policy pursued when purchasing new equipment, and was worded as follows:

"Has your company a policy against the purchase of new equipment unless the production savings will return the initial investment within a definite period? If so, what is the period?"

Nearly 200 replies were received to this questionnaire, disclosing that 43.6 per cent of the companies required that new equipment should return its cost through savings in a period of two years or less, and that 64.1 per cent required that it should pay for itself in three years or less.

The Publishers

WIRE & WIRE PRODUCTS

A monthly publication devoted to wire drawing and wire forming

Vol. 4 August, 1929 No. 8

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THE KRUPP PRODUCT
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NEW YORK

WIRE & WIRE PRODUCTS

Vol. 4 AUGUST, 1929 No. 8

Metal Interests Attend Hearings On Tariff Bill

Swedish wire rod, imported wood screws, and foreign tungsten ore have been items for special consideration

HEARINGS held by the sub-Committee of the Senate Finance Committee considering the metal manufactures schedule of the new tariff bill included several of interest to manufacturers of wire and related products.

The minister from Sweden, W. Bostrom, transmitted a protest from the Swedish Iron Masters' Association in which it was stated that because of their superior quality, Swedish alloy steels do not compete upon a price basis with the domestic product. The same argument of higher quality applied to wire rods, the note contended, and it concluded with the statement that the proposed increase in duty would "undoubtedly cause considerable disturbance in the reciprocal flow of commodities" between the two nations.

Wood Screws

George T. Kimball, of the American Hardware Company, New Britian, Conn., asked for a specific duty on wood screws based on a sliding scale of screw lengths similar to that of the Payne-Aldrich Act. He asserted that the present and proposed rate of 25 per cent is insufficient to protect the industry, and asked for specific, graduated duties of from 3 to 10 cents per gross on screws from ½ inch to 2 inches in length.

Senator King (Dem.), of Utah, a member of the subcommittee, said he objected to the increases asked by Mr. Kimball.

Tungsten

Former Senator C. S. Thomas, of Colorado, speaking on behalf of the David Taylor Company, New York, told the Committee that there are not sufficient tungsten resources in the United States to supply the demand, regardless of what duty might be imposed, and, he said, "It is the highest duty that has ever been imposed by this Government on any raw material." The House amendment to paragraph 301, placing a specific duty of 72 cents a pound on the tungsten content of wrought and cast scrap iron and scrap steel, should be deleted, declared Senator Thomas. He described the existing tariff as "indefensible and unconscionable." Further, he declared, the 5 cents a pound increase on tungsten ore was added by the House without reason, and constitutes "a burden upon industry which is indefensible and restrictive."

George E. Collins, of Denver, representing the Colorado Mining Association, contradicted Senator Thomas' testimony and asserted that, given a price, the tungsten resources are inexhaustible.

Speaking for the Colorado General Assembly, which has passed resolutions and memorials favoring greater tariff protection and has appointed a Committee to urge such increases, George E. Collins of the Colorado House of Representatives, requested of the committee:

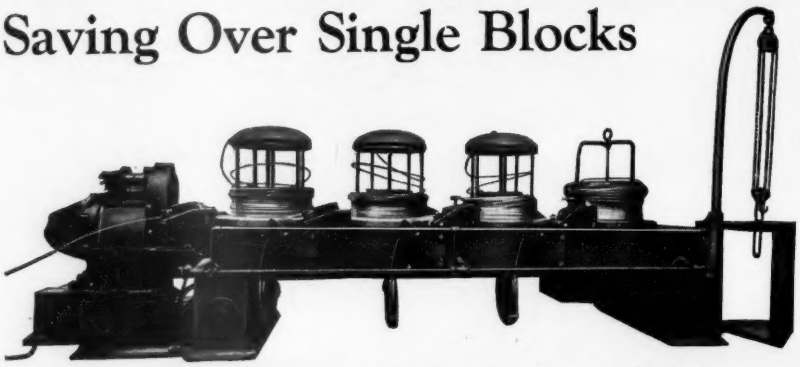
"We respectfully reiterate the request heretofore made on behalf of the tungsten producers of Colorado for a 50 per cent increase in the tariff on tungsten ore and metal, the tariff to include alloys, metal scrap, and all material of every kind and description containing tungsten. Years ago, when the Congressional hearings were held, as a result of which the present tariff was enacted, it was the opinion, practically unanimous, of all those qualified to judge, that a price for tungsten based on the equivalent of 15 dollars per unit of tungstic acid contained in the ore was necessary, in order to justify the investment of capital in the development and operation of tungsten deposits.

"The experience of subsequ-

(*Please turn to page 284*)

Semi-Continuous Wire Drawing Equipment Shows Saving Over Single Blocks

Survey of Colorado Fuel & Iron Company's wire mill shows substantial saving in operating costs after fifteen months of operation.



The Type B Machine with five blocks mounted on a single bench.

TWO Type B Morgan-Connor semi-continuous wire drawing machines were put into operation at the Minnequa works of the Colorado Fuel & Iron Company in March, 1926, and subsequently two Type A and eight Type C machines. The Type B machines draw No. 5 rod in 5 steps to No. 15 wire for plain and galvanized market wire and for use in the manufacture of wire fencing, wire nails, barbed wire, and bale ties.

The report on performance that follows was prepared by A. C. Nielson Company, Engineers, with the collaboration of W. A. Maxwell, Production Manager of the Colorado Fuel & Iron Company at Pueblo, Colorado.

In fifteen months of operation these machines have clearly indicated their ability to produce a high grade of wire with less scrap and at substantially less cost than the single-block wire-drawing equipment which they replaced.

The total cost per 1000 lbs. of wire produced is $2,5781 as compared with $3,7026 on the former single blocks—a reduction of 30% and resulting in an annual saving equivalent to a 48% net return on the entire investment in equipment and auxiliaries.

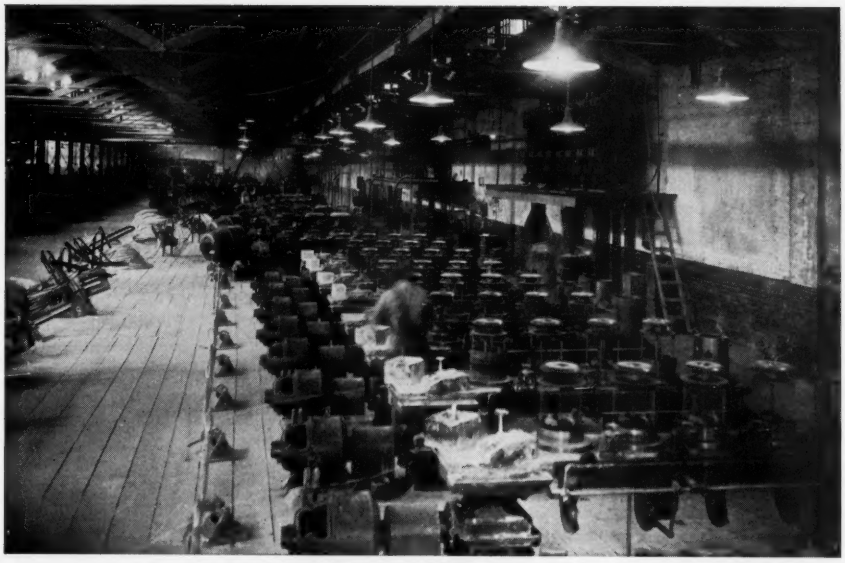
Table E—Comparison of Costs With Type B and Single-Block Methods

CHARGES	COST PER 1000 POUNDS PRODUCED			
	5 Single Blocks Producing 2,945,000 lb. Annually	2 Type B Producing 6,317,000 lb Annually	Saving in Favor of Type B Machine	Per cent Change
Fixed Charges:				
Depreciation	$ .0436	$ .1554	$ .1118	
Interest	.0275	.0746	.0471	
Repairs	.0407	.0459	.0052	
Maintenance	.0207	.0193	.0014	
Floor space	.1093	.0685	.0408	
Total fixed charges	$ .2418	$ .3637	$ .1219	50 inc.
Variable Charges:				
Die cost	$ .0660	$ .0660		
Die lubricant	.1145	.1145		
Power— 43.12 kw.-hr. at $.016	.6899	.6899		
Labor	2.5904	1.3440	$1.2464	48% dec.
Total variable costs	$3.4608	$2.2144	$1.2464	36% dec.
Total of fixed and variable costs	$3.7026	$2.5781	$1.1245	30% dec.
Total annual net saving on the basis of 6,316.780 pounds production—$1.1245 x 6,316.78				$7,103.22
Net annual return on investment in new equipment				48%

The Construction and Equipment

The Type B machine has five blocks mounted on a single bench. The first four receive wire tangentially, store part and deliver axially over the edge of a cast iron dome at the top of the block and down through its hollow spindle to sheaves below the bench which guide the wire to the die of the following block. Correct tension is maintained on the wire as it leaves the block by a guide link in a drag chain operating in a groove around the edge of the dome. Wire accumulates on the fifth block until the bundle is completed and stripped off. Gearing running in an oil bath drives each block at such a rate that it will draw slightly more wire than the following block will require, holding the surplus and delivering it as required until the end of the bundle is reached.

Each machine has a manually



General view of part of the complete wire drawing installation at the Minnequa plant of the Colorado Fuel & Iron Company. The two machines covered by the accompanying survey are in the background.

operated chain hoist for stripping the last block, stock reel, tilting guide for stopping the motor in case of tangles, and motor operated pointer.

Machine Layout

The two machines are placed facing in the same direction at an angle of 45° to the aisles and adjacent to the similarly arranged Type A machines. Rod reels are about 12 ft. from the end of the machines along an aisle on which stock is delivered. Another aisle at the opposite end of the machines is used by trucks removing finished wire. All control equipment is located on an elevated platform along one wall of the building and within plain view of the operators. Including liberal working space about the machine, part of the aisles, and storage space for rod and finished wire, the two machines occupy a space 42 by 32 ft. (1344 sq. ft.)

Operating Method

No. 5 rod of open hearth steel with a carbon content of from .06% to .20% comes from the rod mill in 150-lb. bundles which have been cleaned, lime coated, and baked. The machines deliver finished wire in 16-in. diameter 150-lb. bundles.

A careful check over a period of several days indicates that the average production factor on these machines is close to 80%. Considering that the run-off period for a 150-lb. bundle is about 13 minutes, 80% production factor would indicate an actual loss of machine time due to threading, of only about 3 minutes.

No. 5 rod is drawn to No. 8 to No. 10 to No. 12 to No. 13-½ to No. 15. Some wire is stripped off the intermediate blocks and when the wire breaks underweight bundles are produced which may be used for nails and barbed wire. No. 16 wire has been successfully drawn from No. 5 rod on this machine, but it is seldom done because all of the No. 15 wire that the machine can produce is needed.

Production

Production records for March, April, and May 1927 were studied as representing recent practice and as having such a uniform production that averages taken from them will have a small probable error. During this period there was produced 1,548.485 lbs. of No. 15 GA wire in 237-8 hr. shifts, and average for these 3 months show that 98.1% of the wire was drawn through to No. 15, 1.7% was stripped from intermediate blocks and only .2% was broken into less than full-length bundles. No measurements of scrap have been recorded but it is known to be less than 200 lb. per month, or not more than .380 lb. per 1000 lb. wire produced.

The average production of one machine over these 3 months was 3.332 lbs. of good wire per 8-hour shift or 416 lbs. per hour. Since one operator handles two machines, the output per man will be twice these amounts, or 832 lb. per man hour.

The record production for one shift was made when one man on two machines turned out 8030 lbs. of 5-hole No. 15 wire without a break and with no scrap. Frequently an entire day is run with no breaks and as many as three consecutive days have been run without a break.

Table E. shows both fixed and variable costs and the total. Records show that dies for the Type B machines cost $.066 per 1000 lb. wire produced, and die lubricant costs $.1145. Based on the known cost of fuel and labor for power production, and allowing for transmission losses and investment in equipment, power cost is estimated to be $.016 per kw.-hr.

The total labor cost on these machines from March 1 to May 31, 1927, was $2,122.44, and the production for the same period, 1,579,235 lb. This makes the average cost $1.3440 per 1000 lb. produced.

With a fixed cost of $.3637 and a variable cost of $2.2144, the total is $2.5781.

(*Please turn to page 279*)

Some Practical Suggestions In Reference to Coil Springs

A knowledge of materials, sizes and specifications will enable the user to get the best results from the spring manufacturer

By E. W. Stewart

Sales Manager, The Wm. D. Gibson Company, Chicago

TO the average man a spring is nothing but a coil of wire, and it is not much more than fifty years ago that this was nearly true of those who knew most about them. There was a great fund of facts already in existence in various publications which could be applied to the science of spring phenomena, but they had not been correlated into any practical form.

The great French physicist, Coulomb, after his experiments with his torsion balance, determined over a hundred years ago that a piece of wire, when twisted, resisted the twisting force or torque in direct proportion to the fourth power of the wire diameter; and away back in 1676, Robert Hooke established the fact that stress and strain are proportional within the elastic limit.

The Accepted Formulae

The application of these facts to a coil spring, however, came years later. In the latter part of the nineteenth century, the eminent authority on elasticity, St. Venant, gave to the world the greater part of the mathematical truths upon which our present facility with figures in the design of springs has been based, and the accepted formula in present use for ordinary helical compression springs, known as the Begtrup formula, was published in the "American Machinist" as late as 1892.

In this article no attempt will be made to go into any detail regarding the mathematics of springs, for those who may be further interested reference is made to an article by the writer which went into this subject at some length, which was published in the Journal of the Society of Automotive Engineers in the issue of August, 1925.

A variety of compression springs made from round stock. Some of the more commonly used special shapes include a spring with one conical or tapered end, a conical or tapered diameter spring, and several types of "barrel shaped" springs.

For those who are interested in springs in a more general way, particularly as to the materials used in their manufacture and how to work with the spring maker to best advantage, a few practical notes may help to clear up some questions which arise with regularity in our daily contact with draftsmen and shopmen who are specifying springs.

Four Kinds of Springs

Springs all fall within four general classes, defined as compression, extension, torsion, and flat. The term compression comprises all types which compress or shorten when under load, and give back their stored energy by lengthening when the load is released.

Extension springs are just the opposite, and are designed to be stretched when under load, shortening as the load is removed.

Torsion springs are those which are wound up around a rod or shaft in one direction by a torque load, relaxing in the opposite direction as the load is relaxed.

Flat springs are of many types and applications, but are those made of flat material, such as the leaf springs used to support automobile bodies, rail cars and the like, as well as many lighter uses such as clock or watch springs, and an almost infiinite variety of special shapes for special uses.

In both compression and extension springs the stresses within the wire are torsional, while in the so-called torsion springs, as well as in all flat springs, the stresses within the material are tensile and compressive.

An Interesting Experiment

An interesting experiment to illustrate the operation of a compression spring can be made very simple on a straight rod. If a rod of tempered steel wire be held at one end on a vise, and so mounted at the opposite end as to rotate freely in a bearing, a pulley can be attached to the wire by means of which it may be twisted. A cord around the pully, a weight attached to the

cord, and a means of measuring the distance the weight falls because of the twist in the wire, completes the apparatus.

It will be found that a spring of the same size of wire as the rod above described, with a mean diameter of coil the same as the diameter of the pulley groove, and a length of wire in action around the coil equal to the length of the straight rod, will deflect the same distance under the applied load as does the rod. The mathematical basis of calculating the characteristics of a compression spring is exactly the same as that used to figure the deflection and the stresses in an ordinary line shaft.

Development of Spring Wire

It has been found by experience and test, that the materials which function best under torsional loadings are not always equally satisfactory when the stresses are in bending, as in flat springs, and the chemical analysis as well as methods of fabrication of spring materials depends to a great extent upon the requirements.

As by far the greater percentage of coil springs are made of steel wire of one kind or another, much attention has been given to the development of spring wire of many grades and qualities, from the low priced hard drawn wire used in cheap furniture springs to the electric furnace alloy products used in the most exacting conditions as to high stresses and high temperatures.

Many special alloys have been developed to resist corrosion, or heat, or both; but the principal material is still steel, as nothing has yet been developed which has the elastic properties of steel, or its endurance under repeated stresses.

Perhaps three-quarters of the total number of springs manufactured today in this country are made from a type of wire which has been developed especially for coiling into springs, either in the hard drawn or "patented" condition, or tempered at the mill and coiled into springs after tempering, with no heat treatment after coiling unless given a draw at a relatively low temperature to remove the strains set up in the wire in the process of coiling.

The so-called patented wire is drawn from hot rolled rods, reduced in size by die drawing as far as permissible without breaking or "overdrawing", which is breaking up the structure of the material by carrying the reduction too far, and is then partially annealed, by drawing in a furnace at a temperature somewhat below that required to remove all hardness. It is then further reduced in diameter through successive drawing dies, which intermediate partial anneals, or patenting, resulting in a material which has very high physical properties which are entirely the result of the cold work done on the material, and not of actual hardening by quenching above the critical temperature.

Use of Cold Worked Stock

This stock makes a very satisfactory spring for many purposes, and within its limitations as to the stresses to which it may be safely subjected is perhaps equal to a wire which is actually tempered. Another material widely used, particularly for very small springs, is music wire, such as is made for the strings of pianos and other musical instruments. In the processing of this material the use of the possibilities of cold work by die drawing are carried to their greatest perfection, as it is possible to so produce a wire which has actually higher tensile strength and toughness than it would be possible to obtain in wire of the same chemical characteristices were it hardened and tempered from the annealed condition.

The composition of the patented wire and of some commonly used grades of tempered wire differs from that of ordinary steels used for forgings or other heat treated parts, in that the manganese content is somewhat higher. This has been developed for at least two very good reasons. Steels with manganese within the range of .50 to .80 or .30 to 50%, as with most of the usual SAE steels do not draw as well in drawing dies as a material containing a higher percentage of manganese; the most desirable condition of the crystalline structure in spring wire is that the metallurgist calls "sorbite", which is a finely distributed condition of the crystals of iron carbide within the steel, and about 1%, or slightly less or more, of manganese produces this condition as well as a great facility in die drawing.

Patenting Saves Costs

Further, the hard wire as drawn in the patenting process and also the wire which is actually quenched and drawn in continuous lengths at the mill, is much tougher and more ductile with its high physical properties, than a wire of lower manganese content which has had the same or similar treatment. For these reasons it is possible to coil springs satisfactorily without subsequent hardening and drawing, with a consequent saving in cost which is quite considerable.

Some investigators have claimed that the higher manganese content also is conducive to longer life under fatigue conditions, but that may be open to question, as the tests have never been at all conclusive on that point, but it is true that the vast majority of commercial springs are made of this material today. The Society of Automotive Engineers placed in the order of their most comstandards in 1922 to cover these materials, SAE 1350, and SAE 1360. The former is for wire sizes up to about .100", and differs from the SAE 1360 only in the carbon range, which is slightly lower.

The reason for this was supplied by the wire producers at the time, who pointed out that the tendency in a high carbon

stock was toward a condensation of the heard cementete crystals toward the center of the wire under a great number of dies reductions, resulting in a wire with a very hard core and a softer area toward the outside. The carbon range in the fine sizes is .45 to .55, and in larger sizes .55 to .70%.

For springs of bar sizes over about ½", the most commonly used material corresponds to SAE 1095, and is a hot rolled bar product which is coiled hot, being hardened in oil and tempered by drawing to the required hardness. Many smaller springs are also made of a wire of the same analysis, as well as other special materials both carbon and alloy. These are for more exacting requirements, such as valve springs in high speed automobile engines and aeroplanes.

Almost without exception, the wire manufacturers use the Washburn and Moen standard gauge for steel wire in all grades, and from about .035" up to .331" all gauges are readily obtainable in this standard. For springs smaller than .035" wire, music wire is universally used, and can be had readily down to about .006", in variations of a thousandth or two. Above the .331" fractional sizes run by steps of 1/32" up to about 9/16" and by steps of 1/16" up to 1" in hot rolled bars, from 1" up to 1-½" by steps of ⅛".

Five Principal Dimensions

If the inquiries received from spring users indicate what may be of general interest, they would suggest some notes on what the springmaker needs to know of their problems in order to make most helpful suggestions, and a general discussion of some of these points would assist almost any spring user. We will take them up, therefore, in the order of their common mon use.

Compression springs have five principal dimensions; outside diameter, inside diameter, length, size of wire, and pitch or number of coils. In many cases it is not possible to specify them all, and often it is not advisable to try; but we do need sufficient information to enable us to determine them all.

As to diameters, either outside or inside, and sometimes both, are determined by fixed dimensions of other parts. When this is the case it is advisable to specify the maximum outside and minimum inside diameters permissible. If one is fixed and the other immaterial within reasonable limits, so state. If clearances are required within a tube or over a rod, specify inside diameter of tube and diameter of rod. With springs of large diameter, and particularly if the pitch is greater than three times the wire size, it should be borne in mind that the diameter will increase as the spring is compressed, and proper clearance allowed for this.

The Free Length Factor

Length when free is often of no great importance if lengths under load conditions are met; but if compression springs are required to carry a definite load in pounds at one compressed length, it is necessary to know either the free length required or have some fairly definite idea of the rate, or load per inch, in order to properly design a spring. For instance, a specification requiring a load of 100 lbs. at 5" long, with no qualifying specifications, could be met in various ways by using relatively light wire and a great free length, by using heavy wire and a free length only slightly over the 5", and many gradations between. But if the requirements covered a spring 7" free length, to carry 100 lbs. at 5" long, this is definite and fixes the rate, or scale per inch, at 50 lbs.

Conversely, were the specification for a load of 100 lbs. at 5" and a rate of 50 lbs. per inch, the free length is fixed at 7". Obviously, therefore, a specification covering a load at a given height, a free length, and a rate per inch, must "check" as to these proportions, since in an ordinary helical compression the load is in direct proportion to the deflection. Another specification which often occurs is where two loads are required, at different lengths; for instance 100 lbs. at 5" long and 75 lbs. at 6" long.

In such a case one definite free length, and one only, will satisfy the conditions. The difference in loading is 25 lbs. for a difference in length of 1", therefore, the rate per inch is 25 lbs. It would be necessary to compress the spring from its free length, then, a distance of 3" to build up the initial load of 75 lbs., therefore the free length must be 9". A spring of any other length would fail to meet either one load or the other, whatever its rate per inch.

Oftentimes the length a spring may occupy when closed, or fully compressed, is limited by dimensions of other parts. This should be stated in such cases. It often happens that proper spring space is not available in designs already fixed, to enable the springmaker to design the best spring for the use required. In such cases the only possibility is the best compromise design which can be worked out, and often at the expense of the length of life of the spring. Wherever a spring is an important member of any mechanism, it should be carefully considered in the original design of all other parts, an efficient spring obtained first, and the dimensions of other parts arranged to provide the spring space necessary.

Size and Number of Coils

The wire size and number of coils cannot well be considered separately, as each depends upon the other. For a given outside diameter and length, several combinations of gauge and coils might be possible to meet a given load rate.

The second and concluding instalment of "Practical Suggestions in Reference to Coil Springs" will appear in the September issue.

Standard Specifications Are Drafted For Wires and Cables

American Standards Association proposes tests for weather-resisting and heat-resisting properties of braids and saturating compounds

TECHNICAL Committee number 12 of the Sectional Committee on Wires and Cables of the American Standards Association have prepared a draft of suggested standardized specifications. This draft also contains a section of Heat-Resisting Wires and Cables. The work of this committee is under the chairmanship of Mr. Thomas Sproule of the New Jersey Public Service Corporation.

This report, which follows takes up in detail the covering, the size of conductor, and the saturating compound for weatherproof wires. The drip, bending and melting tests of the saturated cable are explained in some detail. The draft contains a table of weights given in pounds per 1000 feet of cables varying in size from 250,000 to 1,500,000 cir. mil., and includes a section relating to Heat-Resisting Wires and Cables giving the Flame Proofing Test and other material on fire proof cable.

1. Scope

These specifications cover weatherproof wires and cables, and the materials used for the braids and saturating compounds, as applied to metallic conductors.

2. The Covering

The conductor is to be covered by three (or two if the purchaser so specifies) closely woven braids of cotton. The outer braid in all cases is to be of cotton yarn of not less than two ply and two ends and, in the manufacturing process, in any braid, each carrier or bobbin shall carry the same size and same number of ends of yarn (see note 1). The inner braids may contain single ply cotton yarn, or for wire No. 0 and larger, jute yarn. With the consent of the purchaser, other fibrous material or an equivalent filling may be used in place of the inner braids.

The whole covering is to be saturated with a black compound, the saturation to be so thorough that diagonal cuts through the covering down to the conductor shall expose no white or unsaturated ends. The outer braid is to be finished with a smooth hard polished finishing wax so applied as to fill completely all interstices.

SIZE OF CONDUCTOR

Cir. mils			Sq. mm.		
1,000,000 or over			507	and over	
950,000 to 525,000			482	to 266	
500,000 to 225,000			253	to 114	
A. w. g.					
0000 to		1	107	to	42.4
2 to		10	33.6	to	5.26
11 to		14	3.31	to	2.08

The total thickness of the covering is to be considered as one-half of the difference between the diameter as measured over the braids and the diameter of the bare conductor, and must not be less than given in the accompanying table:

3. The Saturating Compound

The saturating compound shall be of such a character as to penetrate completely and fill the braid. It shall be a non-conductor, insoluble in water, and of such quality and use at such temperature that its application shall not injure or cause deterioration of the cotton covering or its equivalent, or the conductor. The completely fabricated wire shall be capable of passing the following test:

(2) *Drip Test* Samples for the drip test shall be cut in lengths of 6 inches (15cm.) and the wire bared for a distance of ¾ inch)2 cm.) from each end. The samples with one end secured in a suitable clamp are then to be suspended at an angle of 45° in an electrical oven approximately 1 foot (30cm.) cube, and maintained at a temperature of 160° Fahrenheit (71°C) for one hour. At the end of this time the compound shall not have dripped, formed globules on the lower side of the sample, or bubbles upon its surface.

(b) *Bending Test.* Each sample for the bending test shall be wrapped six convolutions around its own diameter at room temperature (approximately 68°F or 20°C) and then slowly straightened out. Or it shall be wound on a drum five times its outside diameter, lowered to a temperature of 15° Fahrenheit (-9.4°C), maintained at that temperature for thirty minutes, and then slowly straightened out at the same temperature. After either of these tests the braid covering shall not have broken or cracked. Flaking or cracking of the compound shall not constitute failure.

MINIMUM THICKNESS OF COVERING

in 64th in.	in mm.
8	3.18
7	2.77
6	2.38
5	1.98
4	1.59
3	1.19

(c) *Melting Test.* A piece of clean white glazed paper shall be wrapped around a 6 inch sample of finished wire and it shall be suspended horizontally in a chamber which has been heated to 125°F. (51°C), and the chamber maintained at this temperature for one-half hour. The wire shall be rejected if the compound becomes sufficiently fluid to be transferred to the paper or form a ridge percep-

tible to the finger upon it. The wire with the paper sample is to be cooled before inspection.

4. Stranded Cables

These shall be made up with concentric strand, the number of wires to be as given in the following table:

Size of Conductor*		
Cir. mils	Sq. MM.	No. of Wires**
1,500,000	760	61
1,000,000	507	61
600,000	304	37
500,000	253	37
400,000	203	19
A. w. g.		
0000	107	19 or 7
00 or smaller	85	7

* For intermediate sizes, use stranding for next larger size.

** Conductors of 000 A. w. g. and smaller are often made solid, and this table of stranding should not be interpreted as excluding this practice.

(From the A. I. E. E. Standards of 1925, to be superseded by any changes adopted by the American Standards Association.)

5. Standard Weights

The weights for lengths of weatherproof copper wires supplied under these specifications shall not vary more than three percent from those given in the following table (See Note 2), and the percentage by weight of cotton (or cotton and jute) to the total weight of the covering, shall not be less than 30% or more than 40%.

6. Samples for Test

The tests herein described shall be made upon fair samples, obtained after cutting back at least 2 feet (60 cm.) from the end of the reel or coil as shipped.

7. Tests on Copper Conductors

The specifications for copper wires and cables shall be those of the American Society for Testing Materials (to be superseded by any changes later adopted by the American Standards Association.) Tests shall be run and properties shall conform to these specifications after the weatherproofing process, except insofar as strength requirements are concerned, wherein an additional variation of 5% will be allowed.

Note 1. Definitions

Ends: The number of threads (laid parallel) woven from one bobbin or tube.

Ply: The number of component parts twisted together to form a thread, each part consisting of fibre twisted together.

Note 2.

The 3% variation in total weight establishes a manufacturing tolerance. Should any shipment of wire exceed this manufacturing tolerance by weight, but be satisfactory in all other respects, the purchaser may arrange to accept the shipment by not paying the manufacturer for the weight in excess of the allowable tolerance.

Weights of Weatherproof Wires and Cables
Pounds Per 100 Feet

Size Conductor		Square Millimeters	Stranded Conductor Double Braid	Stranded Conductor Triple Braid	Solid Conductors Double Braid	Solid Conductors Triple Braid
1,500,000	cir. mil.	760	5098	5380		
1,250,000	" "	633	4264	4508		
1,000,000	" "	507	3456	3674		
900,000	" "	456	3127	3332		
800,000	" "	405	2799	2992		
750,000	" "	380	2635	2822		
700,000	" "	355	2471	2650		
600,000	" "	304	2093	2235		
500,000	" "	253	1765	1894		
450,000	" "	228	1601	1724		
400,000	" "	203	1436	1553		
350,000	" "	177	1248	1345		
300,000	" "	152	1083	1174		
250,000	" "	127	907	985		
0000	A. w. g.	107.	745	800	723	767
000	"	85.0	604	653	587	629
00	"	67.4	482	522	467	502
0	"	53.5	388	424	377	407
1	"	42.4	303	328	294	316
2	"	33.6	246	270	239	260
3	"	26.7	190	206	185	199
4	"	21.2	155	170	151	164
5	"	16.8	126	140	122	135
6	"	13.3	103	115	100	112
8	"	8.37	68	78	66	75
9	"	6.63			54	62
10	"	5.26			46	53
12	"	3.31			30	35
14	"	2.08			20	25
16	"	1.31			16	20
18	"	0.823			12	16
20	"	0.518			9	12

Specifications for Heat-Resisting Wire and Cables

1. Scope

These specifications cover the usual type of heat resisting covering commonly known as "slow burning", as applied to metallic conductors for use in hot, dry locations where the standard insulating materials would not long endure or where the presence of large masses of inflammable materials would be objectionable. (See Note 1). Materials and Properties

2. Number of Braids

The coverings for all slow-burning wires and cables shall consist of at least two braids for wires No. 18 and 16 A. w. g. and at least three braids for wires No. 14 A. w. g. and larger, all of which braids must be thoroughly treated and filled.

3. Material and Workmanship

Braids must be cotton or other approved fibrous material and must in all cases conform as to lay with standard samples and must show good workmanship.

4. Thickness

Braids shall be not less than 1/64 inch (0.40 mm.) in thickness, and for conductors larger than No. 10 A. w. g. the outer braid shall be not less than 1/32 inch (0.79 mm.) in thickness. The total thickness of the covering is to be considered as one-half of the difference between the diameter as measured over the braids and the diameter of the bare conductor, and must not be less than that given in the following table:

SIZE OF CONDUCTOR				
Cir. mils			Sq. mm.	
1,000,000 or over			507	and over
950,000 to 525,000			482	to 266
500,000 to 225,000			253	to 114
A. w. g.				
0000 to	1		107	to 42.4
2 to	10		33.6	to 5.26
11 to	14		3.31	to 2.08

MINIMUM THICKNESS OF COVERING	
in 64th in.	in mm.
8	3.18
7	2.77
6	2.38
5	1.98
4	1.59
3	1.19

(*Please turn to page 281*)

Lift Trucks and Separate Bodies Speed Up Production

Reprinted from "Exide-Ironclad Topics" through the courtesy of The Electric Storage Battery Co.

Left—Wire about to be placed on conveying machine for annealing.

Center—Lift-truck bodies loaded with coils of wire ready for swaging machine.

Above—Battery truck picking up raw material in the storage yard.

Greatly increased manufacturing efficiency results from installation of lift-truck bodies and storage battery truck in Driver-Harris plant

EVEN though it may be hard to "teach an old dog new tricks," it does not follow that an old experienced manufacturer cannot be persuaded to try new methods which give promise of speeding up his production and increasing the efficiency of his plant.

For many years, the Driver-Harris Company has been known as a manufacturer of nichrome wire. Their plant at Harrison, N. J., is one of the best equipped in the East. Recently, the officials of the Company made their initial installation of electric industrial truck equipment. Further installations are contemplated, even though they involve some physical changes in the plant. Just what effect these changes will have, it is hard to say, but judging by what has already been accomplished, the results will warrant the expense and effort.

The accompanying photographs illustrate the steps that are now being simplified through the use of the Company's first elevating platform truck and a number of lift-truck bodies.

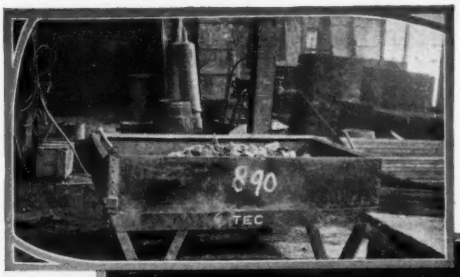
As may be seen at a glance, the first operation performed by the truck is to run out into the storage yard and pick up a body loaded high with the rough product just as it comes from the rolling mill.

This body is then deposited by the truck on the scales—the next step before the wire goes into process. Placing the body with its load on the scale the truck backs out from under it so that only the body and the load are weighed. The weight of the body is painted on its side (in this case 610 pounds), so that the exact weight of the raw material is easily arrived at. If the truck also were weighed, figures would vary because of the accumulation of mud and ice on the truck.

After again picking up its loaded body, the truck deposits it at the swaging machine where the end of the wire is reduced in size so that it can be entered in the drawing-die.

Next a load of the drawn wire is carried to and deposited at the beginning of the endless chain which takes the wire to the annealing furnace. At the other end of the furnace, lift truck bodies receive the wire as fast as it comes off the chain, and these in turn are picked up by the truck and carried to another point in the plant.

(*Please turn to page 283*)



Detached truck bodies, like the one here shown in the Cleaning Room, are used to collect Nichrome scrap to be reclaimed.

The top of a lift-truck body forms part of the floor of the Cleaning Room when not loaded. When full it is replaced with another body.

NEWS *of the* INDUSTRY

Foreign Trade Opportunities

FOREIGN trade opportunities reported by the U. S. Bureau of Foreign and Domestic Commerce during the month of July include inquiries from the following sources: For insulated wire for automobiles (39202) from Alexandria, Egypt; for wiring supplies (39214) from Tallinn, Estonia; for wiring supplies (39215) from Vienna, Austria; for wiring supplies and lighting fixtures (39250) from Montreal, Canada; for galvanized wire (39224) from Valparaiso, Chile; for insulated cables for automobiles (39324) from Prague, Czechoslovakia; for bolts, nuts and steel brushes (39368) from Montreal, Canada; for nails (39391) from Penang, Straits Settlements; for galvanized wire in rolls (39435) from Patras, Greece; for wire netting (39366) from Oslo, Norway; for small iron link chain manufacturing machinery (39390) from Rosario, Argentina; for a key making machine for shoe polish can keys (39406) from San Salvador, El Salvador; for wire fabric making machinery and bed-spring manufacturing machinery (39392) from Sao Paulo, Brazil; for wire strapping machines for cases, bales and frames (39435) from Patras, Greece; for wiring devices and fixtures (39460) from Winnipeg, Canada; for wire netting and fencing (39498) from San Juan, P. R.; for insulated wire and cable (39612) from Poznan, Poland; for wiring supplies and rigid and flexible conduits (39614) from Sao Paulo, Brazil; for galvanized wire netting (39665) from Shanghai, China; for wire nails (39657) from Tenerife, Canary Island; for wire nails (39665) from Shanghai, China; for nail cutting machinery for iron nails (39674) from Valparaiso, Chile; for automatic wood screw manufacturing machinery (39706) from Tampico, Mexico.

British Develop Apparatus for Detecting Flaws in Colliery Ropes

AT the 8th general meeting of the British Institution of Mining Engineers, which has just been held at the University College, Nottingham, Eng., considerable interest was taken in an experimental demonstration given by Dr. F. T. Wall with an apparatus for the electric testing of colliery wire ropes. Dr. Wall showed the possibility of detecting by normal frequency a large flaw in a wire rope, and then, by higher and more sensitive frequences, smaller flaws. Major Currer Briggs stated that the instrument demonstrated would be of considerable use to the industry, and suggested that after a rope had been in use it should be tested and then, if satisfactory, a certificate should be given for a further period.

National Electrical Code

THE National Electrical Safety Code, issued by the Bureau of Standards as a standard for electrical construction from the standpoint of accident prevention, has been adopted in whole or in part by half the States of the Union and it has been applied also in some of the Canadian Provinces, the Department of Commerce announces.

The National Electrical Safety Code, issued by the Bureau, is generally recognized as a standard for electrical construction which establishes good practice from the standpoint of accident prevention. It has been widely used by contractors and by utility companies operating in the fields of electric light, power, railways, telephone, and telegraph, and by electrified railroads. It is frequently referred to by State and municipal officials, and is a standard of reference for matters in dispute.

Sheffield's New Steel Research Laboratory

A FINE new laboratory for research on the cold-working of steel has just been opened in England at the University of Sheffield. The mechanical equipment includes a wire and bar drawing plant constructed by Messrs. George Crossley, of Cleckheaton. By means of a two-speed gear and variable speed motor, wire drawing speeds of from 28 to 360 feet per minute may be obtained, and wires can be drawn of all sizes up to ⅜-inch diameter and rods up to 1-inch diameter. The motor can develop 20 h. p. throughout its range of speed.

Personal

Carboloy Co., Inc., distributors of tungsten alloy wire drawing dies, 350 Madison Avenue, New York, has opened a New England office at Bridgeport, Conn., in the City National Bank Building. H. R. Hayter is in charge.

The Adrian, Michigan, plant of the Page Steel & Wire Co., subsidiary of the American Chain Co., Inc., has appointed Edward A. Heckert as manager and George Y. Greiman as superintendent. Both have formerly been connected with the plant of the same company at York, Pa.

Fusion Welding Corporation, 103d St. and Torrence Avenue, Chicago, has taken over the sale of all welding rod manufactured by its parent company, Chicago Steel & Wire Company. The change provides one source of

supply for both Weldite welding rods and Fuzon welding equipment and accessories previously sold by the two companies. There is no change in the personnel in charge.

Building and Expansion

Newhall Chain Forge & Iron Co., 9-15 Park Place, New York City, has completed negotiations for the purchase of the Rensselaer Chain Works at Rensselaer, N. Y., together with adjoining properties to permit of extensions.

Hayden Wire Works, Inc., Springfield, Mass., has been formed by Charles E. Hayden, Erma A. Randall and Richard J. Talbot, all of Springfield.

Marlboro Wire Goods Co., Marlboro, Mass., has started work on a new three-story addition to present plant providing about 10,800 square feet of new floor space.

Oxford Radio Corporation, formerly of Chicago, has moved its coil winding department to Muskegon, Mich. From the same city it is reported that Maring Wire Co., subsidiary of Anaconda, is adding 32,000 feet of floor space and that the American Enameled Magnet Wire Company has appropriated one hundred thousand dollars for an expansion program.

Philadelphia Insulated Wire Co., 200 North Third Street, Philadelphia, has taken over an adjoining factory property that will provide about 7500 additional square feet of floor space.

Wolverine Screw Co., St. Jean Avenue, Detroit, will build and equip an addition at an estimated cost of $40,000.

Providence Spring Bed Mfg. Co., 355 Washington St., Providence, R. I., has been organized to manufacture bed springs and kindred products and is reported to be in the market for materials.

COMING EVENTS

September 9-12. Annual meeting The Institute of Metals (British) at Dusseldorf, Germany. G. Shaw Scott, Secretary, 36 Victoria Street, London, S. W. 1.

September 9-13—National Metal Congress in Cleveland, Ohio. Simultaneous meetings with the American Welding Society; Institute of Metals Division, American Institute of Mining and Metallurgical Engineers; Iron and Steel Division, American Society of Mechanical Engineers; Iron and Steel Division American Institute of Mining and Metalurgical Engineers; and American Society for Steel Treating. W. H. Eisenman, Secretary, 7016 Euclid Ave., Cleveland, Ohio.

September 24-26. Railway Equipment Manufacturers Assn. at Chicago. Secretary, F. W. Venton, 836 S. Michigan Ave., Chicago.

September 9-14. National Assn. of Power Engineers at Chattanooga, Tenn. Secretary, F. W. Raven, 417 S. Dearborn St., Chicago.

September 30-Oct. 4. National Safety Council Congress at Chicago. Secretary, W. H. Cameron, 108 E. Ohio St., Chicago.

October 14-16. National Assn. Manufacturers of the United States at New York. Secretary, J. Lewis Bentor, 11 W. 42nd St., New York.

October 21-26. Railway Electrical Supply Manufacturers' Assn. at Chicago. Secretary, Edward Wray, 9 S. Clinton St., Chicago.

October 15-17. Bridge and Building Supply Men's Assn. at New Orleans. Secretary, I. B. Tanner, 332 S. Michigan Ave., Chicago, Ill.

October 29. World Engineering Congress, Tokio, Japan. George W. Fuller, Chairman American committee on attendance, 170 Broadway, New York City.

December 2-6—Annual meeting of the American Society of Mechanical Engineers at the Engineering Societies Building, 29 W. 39th St., New York City. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

December 2-7. National Exposition of Power and Mechanical Engineering at New York. Address Charles F. Roth, 420 Lexington Ave., New York City.

December 18. International Assn. Municipal Electricians at Boston. Secretary, H. N. Lang, City Hall, Orlando, Fla.

American Coil Spring Co. has begun removal of its plant to Muskegon, Mich., the first unit to be installed being its subsidiary, the Monarch Steel Treating Company.

John A. Roebling's Sons, Trenton, N. J., manufacturers of wire rope, cable, etc., will build and equip an addition at an estimated cost of $125,000.

Excelsior Wire Works, 319 W. Maryland St., Indianapolis, Ind., manufacturer of bird cages, etc., has removed to a larger plant at 19th Street and Martindale Ave.

Anglo-Canadian Wire Rope Co., Fairview Avenue, Lachine, Quebec, has broken ground for a new factory addition to its present plant.

Metalkloth Co., Inc., Garibaldi Avenue, Lodi, N. J., manufacturers of wire filter cloth, etc., will build and equip an addition at an approximate cost of $45,000.

Wire Fabrics Corporation, Mount Wolf, Pa., manufacturers of wire cloth, will build and equip an addition at an estimated cost of $40,000.

Chicago Screw Co., 1026 South Homan Avenue, Chicago, is planning a four-story addition to its present plant.

Iowa United Telephone System, Harlan, Iowa, is expanding its wire plant at an estimated cost of $10,000. About 5,000 feet of cable and twenty five miles of wire will be placed this summer and fall.

Standard Underground Cable Co., 17th & Pike Streets, Pittsburgh, will build and equip a plant at Perth Amboy, N. J., at an estimated cost of $200,000.

Electrical Research Laboratories, Inc., 2500 Cottage Grove Avenue, Chicago, manufacturers of radio equipment, will occupy part of Cable Piano Company plant as part of expansion program.

Worcester Wire Works, 379 Main Street, Worcester, Mass., has broken ground for a new two-story addition to its plant.

Sleeper & Hartley
TRADE MARK
REG. U.S. PAT. OFF. & PRINCIPAL FOREIGN COUNTRIES

Practical Wire Wo

These Machines Go Into Production at O—R

Continuous Rod Frame

(No. 5—14 or 15 wire)

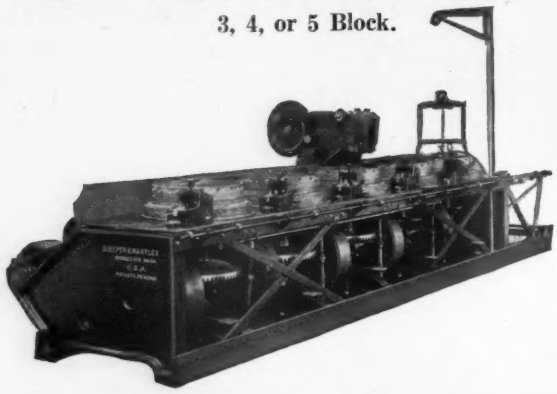
Patented June 3, 1924—May 12, 1925—others pending

All Ball or Roller Bearings

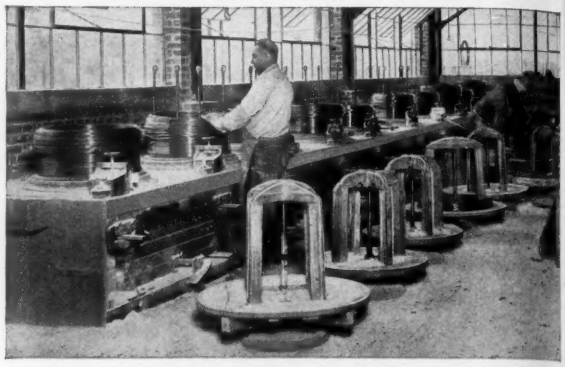
No Differential Gearing.

Automatic Compensation for Speeds of Heads.

3, 4, or 5 Block.



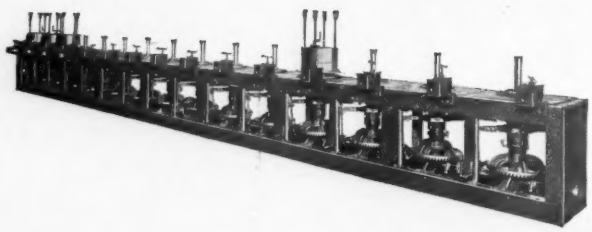
Single Hole Drawing



Standard Rod Frame—10 Block

Long, Stiff Spindles, in anti-friction bearings, and equipped with friction Clutches. Powerful and reliable. Practically noiseless in operation.

(New Plant of Thompson Wire Co., Worcester, Mass.)



Heavy 16" Frame For .65 Carbon Wire
No. 10½ to .037"

15 Blocks: Motor driven. Silent chain. Anti friction bearings and cut gears throughout.

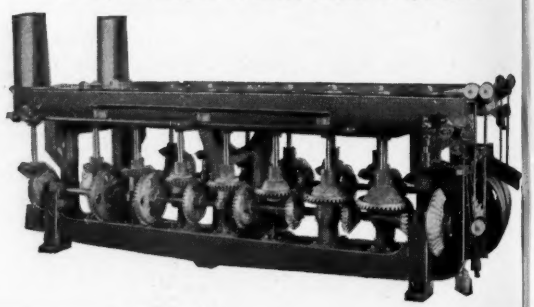
(New Plant of Johnson Steel & Wire Co., Worcester, Mass.)

Double 8-Draft Fine Wire: We

No. 22 to 36. High or low carbon wire.

6 Blocks to Average Operator, 22-33, 8-hole, 660 lbs. per day of ten hours.

Many thousands of these heads in operation



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SAN FRANCISCO AND LOS ANGELES
L. G. Henes Machinery Company

FOREIGN AGENTS AND REPRESENTATIVES: UNITED KINGDOM—Mr. Fredk. A. Perry, 63 Queen Victoria St., London, E. C. 4.
AUSTRALIA AND NEW ZEALAND—Edwin Wood Pty. Ltd., Melbourne
MONTREAL AND TORONTO—Arthur Jackson Machine Tool Co.
JAPAN—Andrews & George Co., Tokyo

SLEEPER & H

orking Machinery

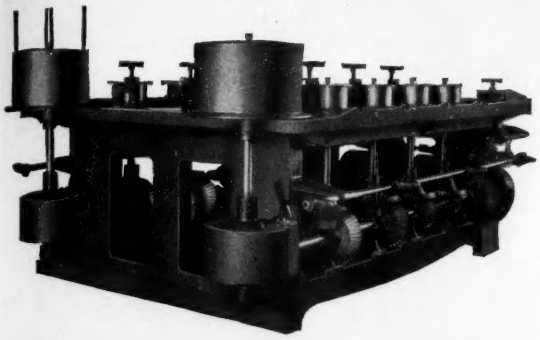
Sleeper & Hartley TRADE MARK

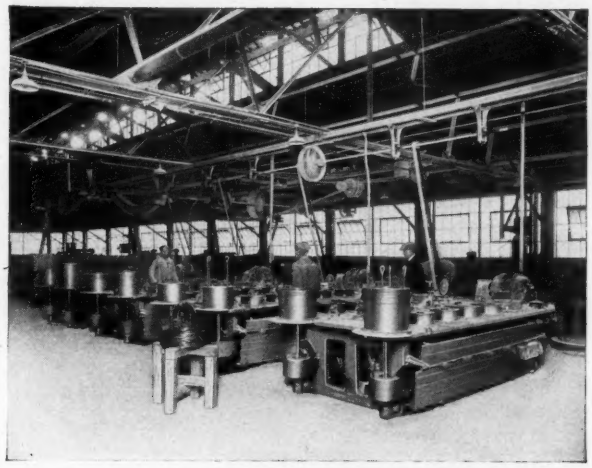
—Reducing Overhead—Increasing Production!!

Double 5-Draft Dry, Intermediate

No. 14 to No. 23. High or low carbon wire.
3 to 4 Blocks to Average Operator.
No. 14 to 19—4 hole, 1400 lbs. per block.
No. 14 to 20—5 hole, 1100 lbs. per block.

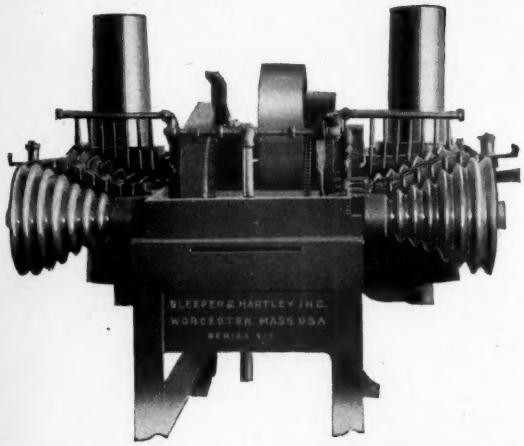
More than 300 heads of this improved model in operation



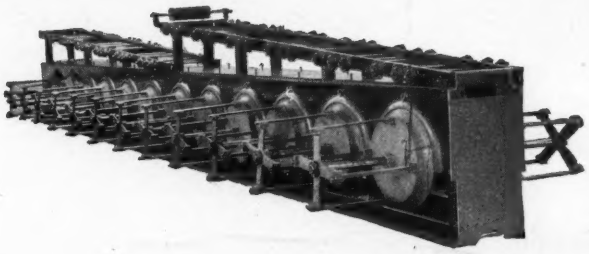


Battery of Double Six-Draft Dry Continuous For High Carbon Wire

Direct driven with silent chain. Cut gears throughout. Anti-friction bearings. Variable speed for finishing block. (New Plant of Thompson Wire Co., Worcester, Mass.)



Improved Double 8-Draft Cone Type Continuous Wet Wire Drawing Machine



Patenting Furnace Take-Up

(New Plant of Thompson Wire Co., Worcester, Mass.)

NEW YORK TERRITORY—Triplex Machine Tool Co.

Philadelphia Territory
Swind Machinery Co.

ARTLEY, Inc., WORCESTER, MASS., U. S. A.

DIGEST *of* RECENT TRADE LITERATURE

Life Tests on Metallic Resistor Materials for Electrical Heating. Paper presented at annual meeting (June) of the American Society for Testing Materials, Philadelphia, Pa.

A report of an accelerated durability test devised as a measure of the quality of the material used in the heating unit as regards length of useful service. The authors are F. E. Bash, Manager, Technical Department, Driver-Harris Co., Harrison, N. J., and J. W. Harsch, Assistant Chief Engineer, Leeds and Northup Co., Philadelphia. Tests were made on the effects of all variables encountered in a life test, the most important of these being (1) Temperature, (2) Heating and cooling cycles, (3) Mounting, (4) Dimensions of test specimen, (5) Atmosphere, (6) Voltage variation. All previous types of tests were considered and life tests were established after many comparative tests had been made on the same wire in five different laboratories. The authors conclude that an accelerated test on electrical resistor wire can be made which will be reproducible and they believe it will give results which are a measure of the quality of the material used.

Automatic Plating Machinery. Industrial & Engineering Chemistry, May, 1929, P. 400.

A comprehensive description of current practice by Edwin M. Baker, Department of Chemical Engineering, University of Michigan. It is a comparatively few years since the use of automatic plating machinery was exceptional and the usual method was for workmen to carry the articles to be plated from tank to tank. Today both automatic and semi-automatic handling of plating operations are common. In addition to equipment the author discusses the preparation of articles for plating, the developments that have resulted in more rapid plating methods and the meeting of the demand for more uniform quality of electro-deposited coatings. Actual methods in use in American plants are described and the article is illustrated with photographs and diagrams of plating room layouts.

Fatigue and Corrosion-Fatigue of Spring Material. Transactions, American Society of Mechanical Engineers, 29 West 39th St., New York City.

The author, D. J. McAdam, Jr., Metallurgist of the U. S. Naval Engineering Experiment Station, Annapolis, Md., presented this paper at the annual (December) meeting of the A. S. M. E. Certain facts and relationships that have been established as the result of numerous investigations of fatigue of metals are briefly mentioned and defined. Chief attention is given to the endurance properties of spring material under complete reversal of stress per cycle, with some tentative conclusions as to the endurance properties under actual service conditions. The subject matter of this study includes the relation of the endurance limit to other physical properties, endurance properties of steel, endurance properties of nickel-copper alloys and of copper-tin alloys, effect of varying the position of the endurance range within the elastic range, effect of abrupt changes of section, corrosion-fatigue of spring steels and of non-ferrous alloys, metallic protective coatings for spring material, and effect of cycle frequency on fatigue and corrosion fatigue.

Trade Literature Received

Drawing Dies

"Instructions for Repolishing and Resizing Un-Widia Alloy Dies." Bulletin 102. Union Wire Die Corporation, 333 West 52d St., New York City. Describes equipment required and method employed and supplements Bulletin 101. Both booklets are punched to permit their use in leather covered loose leaf binders and are items in a series which will be mailed as issued to interested inquirers.

Metal Specialties

"Classifications of Metal Specialties". Industrial Metal Company, 2900 E. Cumberland St., Philadelphia, Pa. Folder containing brief definitions of metal specialities, mineral alloys and industrial by-product metals which the company purchases and reclaims.

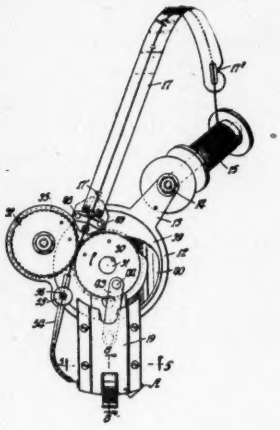
Metal Cleaning

"Scale". N. Ransohoff, Inc., 5000 Spring Grove Ave., Cincinnati, Ohio. Illustrated folder featuring company's metal scale removing process and offering fuller particulars of specific applications for metal cleaning, tumbling, polishing, dipping, drying and pickling.

X-Ray Tests

"X-rays in Industry." Eastman Kodak Company, Rochester, New York. 60 pages. Illustrated from photographs. Describes industrial applications of x-rays in inspecting the internal construction of opaque materials, particularly metals. Tells briefly how x-rays are produced and discusses apparatus and technique. Appendix contains valuable bibliography of books and technical journal contributions on the subject.

A REVIEW *of* RECENT PATENTS



1,718,199 Wire Stitcher

No. 1,718,199, WIRE STITCHER. Patented June 18, 1929, by Gottfried P. Baumann, of Chicago, Illinois, assignor to Ideal Stitcher & Manufacturing Company, of Chicago, Illinois. One of the features of this wire stitcher or stapler is the provision of an improved and simplified roll feed in which one of the feed rollers is carried directly by the main shaft, also operating in such a way that adjustment is provided to vary the length of the wire fed and thus the size of the staple.

No. 1,718,200, CHECK PAWL FOR WIRE STITCHERS. Patented June 18, 1929, by Gottfried P. Baumann, of Chicago, Illinois, assignor to Ideal Stitcher & Manufacturing Co., of Chicago, Ill. The invention relates to check pawls for wire stitchers and has to do more particularly with devices of the above character adapted to check a restoring or return movement of the wire being fed to the machine, although permitting movement of the wire in feeding the stitchers.

No. 1,716,860, SEAM FOR WOVEN WIRE BELTS AND METHOD OF MAKING IT. Patented June 11, 1929, by Hamilton Lindsay, of Cleveland, Ohio, assignor to Lindsay Wire Weaving Company, of Cleveland, Ohio. This invention relates to seams for woven wire belts, particularly those which are adapted for use in connection with the operation of Fourdrinier paper making machines. Usually seams for belts of this character have a stitching forming wire which passes over one or more weft wires to reinforce the ends of the belt, while a closing wire is used for joining the ends of the belt. The inventor provides for fastening adjacent warp wires together independently of the weft wires to form loops at each end of the belt, and then passing a closing wire across the seam opening and thru the loops.

Complete descriptions and drawings of any of the patents referred to on this page may be had for twenty-five cents. Address orders to Wire & Wire Products, 551 Fifth Avenue, New York City.

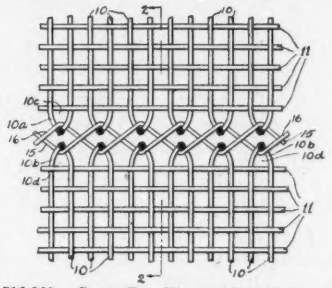
No. 1,717,558, CONNECTING LINK FOR TIRE CHAINS. Patented June 18, 1929, by Herman Hanson, of Garfield, Minnesota. The assembly includes a coil spring and wire retaining clips for the same, the spring being provided for taking up slack in the tire chain.

No. 1,716,844, WIRE TWISTING MACHINE. Patented June 11, 1929, by Anton Van Veen, of West Hartford, Connecticut, assignor to the Fuller Brush Company, of Hartford, Connecticut. This invention relates to the class of wire twisting machines more especially designed for use in the manufacture of brushes in securing bristles or other material to a wire structure by a twisting operation. In the operation of twisting the brush material, two wires are commonly employed, the brush material being evenly distributed in a layer between the wires. The machine being operated to twist the wires, such wires are consequently shortened, and the mechanism comprised in this invention is constructed to permit this shortening of the wires and to permit the chuck jaws to be opened without changing their position with respect to the wires, and by a single movement of the chuck actuating levers.

No. 1,717,949, SPRING SEAT. Patented June 18, 1929, by Maurice Stubnitz, of Pittsburgh, Pennsylvania, assignor to Fort Pitt Bedding Company, of Pittsburgh, Pennsylvania. In this spring seat for automobiles, etc., the arrangement includes tie-wires connecting the top coils of the springs together and lying in a substantially horizontal plane in alinement with the top coils and extending over the openings between the springs.

No. 1,718,571, STAPLING MACHINE. Patented June 25, 1929, by Fred L. Manny, of Benton Harbor, Michigan, assignor to F. P. Rosback Company, of Benton Harbor, Michigan. This machine is of large capacity and designed to be adjusted to space the wire stitches or staples as may be desired for the particular work. The machine is given considerable adaptability by the variation in speeds and variation in the timing of the feeding action of the fee rollers. From the stitcher feed rollers the work is delivered to the discharge conveyor which is capable of adjustment to the particular work.

No. 1,718,522, SUPPORT FOR WIRE MATTRESSES. Patented June 25, 1929, by Charles Albert Brandreth, of Ilford, England. The



1,716,860. Seam For Woven Wire Belts and Method of Making It.

invention relates to supports for wire mattresses for re-inforcing the wire fabric of the mattress, to prevent sagging, of the kind in which a plurality of coiled springs are mounted on a separate frame suspended from the frame of the mattress, and adapted to support the wire mattress fabric at its weakest point.

No. 1,718,386, RUBBER COVERED WOVEN SCREEN. Patented June 25, 1929, by Charles Frederic Sherwood, of Detroit, Michigan, assignor to Oliver Sherwood Co., of San Francisco, California. The woven wire mesh, in this invention is covered with rubber, the object being to adapt the screen to be used for materials which ordinarily have an abrasive or corrosive action upon screens as they have generally been made.

No. 1,717,953, FOLDING BED BOTTOM FABRIC. Patented June 18, 1929, by Frank A. Adkins, of Chicago, and Noah S. Harter, of Waukegan, Iillinois, assignors to Champion Folding Furniture Company, of Waukegan, Illinois. This inventior relates to a folding fabric bed bottom, adapted for use on folding bed frames, such as that illustrated in the patentees' co-pending application Serial Number 206,097; filed July 15, 1927. The bed bottom fabric comprises a number of wire strands extending transversely of the bed frame, each strand bent to form a series of relatively long angular loops, opening alternately in opposite directions.

No. 1,715,641, SPLICING MACHINE. Patented June 4, 1929, by James W. Channell, of South Gate, California. This invention relates to a machine for splicing wires of a telephone or telegraph cable, or other like structures, and is described as an improvement on the machine outlined in the patentee's application No. 684,314, filed January 1st, 1924, patented January 3rd, 1928, No. 1,654,-788; and the object thereof is to produce a machine that will twist two wires together, or a plurality of pairs of wires, and place an insulating sleeve over the twisted portions, in a simpler manner than the machine described in the patentee's other application.

Great Wire Ropeway Now Spans Himalayas

British engineers complete fourteen-mile span among world's highest mountain peaks

THE great Nepal Ropeway, which was recently completed for the conveyance of merchandise over valleys and passes lying between the Indian frontier and Katmandu, the capital of the Kingdom of Nepal, constitutes a very remarkable feat of engineering. The way into Nepal has always been extremely difficult, there being no roads over the two great spurs of the Himalayas which divide it from the Indian plains.

Replaces Coolie Trains

From time immemorial freight has had to be transported by men, the paths being too steep for animals. Heavy machinery and other bulky articles have been carried by armies of coolies, by means of hundreds of bamboo poles lashed together. In this crude way the hydro-electric plant installed before the War was conveyed to the neighborhood of Katmandu, though oxen could be used in the first stage of the journey, through the Terai, one of the wildest jungles in the world.

Katmandu is 72 miles from Raxaul, a terminal station on the Bengal & North-Western Railway. A road has been made and a light railway provided on fairly level but slightly rising ground from Raxaul to Bichako, a distance of 22 miles. Freight is then carried on to Dhursing by a road, which is moderately good when it has been repaired after the heavy monsoon rains. There it is received at the terminus of the new Nepal Ropeway, which derives its power from the hydro-electric works near Katmandu.

The line is about 14 miles in length, and passes through difficult country in the foothills of the Himalayas, carrying freight into the Nepal Valley over two great ridges of mountains each 7,000 feet or 8,000 feet high. The 4,000-ft. span over the Khuli Khani gorge is one of the longest in the world, the only others which might dispute the claim being two in the Swiss Alps.

The wire ropeway, which was constructed under the direction of R. S. Underhill, with R. Pearson and A. J. Knight as consulting engineers, is divided into seven sections. The driving gears are placed in pairs at alternate stations, the motors at which are capable of serving the two adjacent sections. By the addition of further sections it can be extended indefinitely, and proposals for bringing its terminus eight or nine miles nearer to the railhead at Bichako are under consideration. Despite the large sums spent on the road between Dhursing and Bichako, portions of it are washed away each monsoon, most of the trouble occuring within a few miles of Dhursing.

Carries Miscellaneous Freight

The ropeway is arranged to carry miscellaneous freight in both directions, and has a working capacity of 9 tons per hour. The average load is 5 cwt., and the heaviest load permissible is 10 cwt. Tray carriers are used for general merchandise, and carriers provided with sling chains for loads of long timber, two carriers being connected together in the latter case. The wire rope is seven-eights of an inch thick and travels continuously at 4¼ miles per hour. It is supported by sheaves running on ball bearings carried on cross arms at the tops of 106 steel trestles, which vary in height from 12 feet to 100 feet, to suit the configuration of the ground.

The engineers had to solve many perplexing problems. The weather conditions did not permit construction to be carried on for more than six months of the year. The transport problem was so acute that special gear was provided for running the sections at a slow speed after each was completed, for the purpose of transporting the ropes for a further section by ropeway so far as possible.

Ballast Supplies Tension

Owing to the length of some of the sections, the allowance to be made for stretch in the rope on account of the extremes of temperature, and the nature of the ground encountered, it was found that several of the pits for the tension gear would have to be of almost prohibitive depth. Consequently the tension was obtained by means of ballast wagons working on an incline, instead of the more usual weight hanging in a pit. Another obstacle was the belief in scattered villages that the opening of ropeway was to be celebrated by the immolation of children at the foot of the trestles, and in some cases Mr. Underhill found villages emptied as he approached them.

In several places trouble was caused by roaming elephants using trestles under erection as rubbing posts. A separate short ropeway, 2½ miles long, carrying road metal from quarries near Katmandu into the city at the rate of 4 tons per hour, constitutes an addition to the original plans.

Domestic Exports and Imports of Iron and Steel Wire and Wire Products

Exports of iron and steel wire and wire products from the United States in April and May, 1929
(In gross tons)

Item	May 1929	April 1929	May 1928	January through May 1929	January through May 1928
Wire rods	3,197	4,551	3,551	20,286	13,711
Plain wire	3,158	4,146	3,808	22,348	19,015
Barbed wire and woven wire fencing	5,409	5,137	7,156	29,293	31,426
Wire cloth and screening	142	116	119	762	680
Wire rope	505	586	402	3,184	2,148
Insulated wire and cable	115	48	64	549	252
Other wire and manufactures of	961	785	805	4,474	3,615
Wire nails	513	1,355	1,830	7,006	7,307
Nails other than wire	482	1,069	716	4,138	3,812
Tacks	55	54	56	283	355

Imports

Imports of iron and steel wire and wire products into the United States
(In gross tons)

Item	May 1929	April 1929	May 1928	January through May 1929	January through May 1928
Wire rods	2,778	1,339	1,824	7,230	8,298
Barbed wire	360	742	308	2,353	1,566
Round iron and steel wire	467	778	239	2,971	1,688
Steel telegraph and telephone wire	....	....	82	....	118
Flat wire and strip steel	346	160	332	941	1,073
Wire rope and strand	206	193	121	1,008	619
Other wire	77	47	46	264	277
Nails, tacks, and staples	1,099	549	821	3,461	3,155

Preliminary figures for United States electrical wire and wire product exports
(In dollars)

Article	May 1928	May 1929	5 months ended May 31 1928	5 months ended May 31 1929
Insulated wire and cable, iron or steel	$25,496	$39,901	$97,063	$199,544
Copper, bare wire	203,712	393,095	965,420	1,637,424
Copper, insulated wire and cable	426,190	468,618	1,827,253	2,854,103
Insulating material	120,314	78,422	537,250	568,167
Other wiring supplies and line material	78,868	110,566	400,769	538,766

IMPORTS of card clothing for the third consecutive month were less than in the month preceding, amounting to only 18,151 square feet, valued at $32,144, in contrast with 26,210 square feet, valued at $42,842 for April. The bulk of the receipts originated in the United Kingdom, 14,158 square feet, valued at $23,862, with smaller amounts coming from Belgium, Germany and France. Imports of wire cloth and screening increased slightly to 40,131 square feet the preceding month. Germany supplied 27,464 square feet of the total and France 11,730 square feet.

The trade in wire heddles declined, amounting to only 4,032,000 pieces, against 4,932,000 pieces for April. The principal source of these imports was France (2,855,000), with smaller quantities coming from Germany (748,000), Belgium (311,000), and Czechoslovakia (115,000).

Wood-screw imports were greatly reduced, and totaled only 3,653 gross, valued at $582, against 26,484 gross, valued at $2,180. Sweden was the principal source, sending in 2,820 gross, valued at $387, with the remainder coming from Germany, 833 gross, valued at $195.

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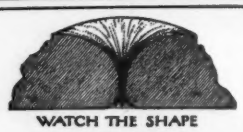

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(U. S. Patent 1,624,027. April 12, 1927.)

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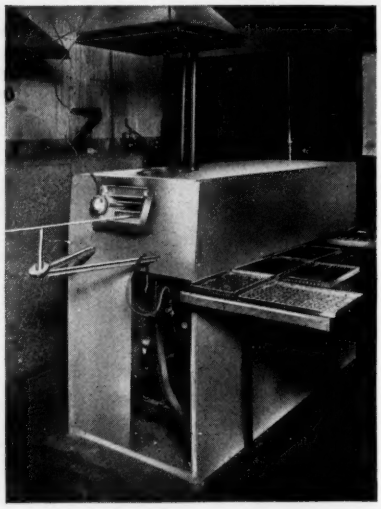
New Type Annealing Furnace



A NEW type annealing furnace has been placed on the market by Weisberg & Greenwald, 71 West 45th St., New York City. The new type furnace, known as the Brandt, anneals, solders and heat treats metals without oxidizing them and deoxidizes metals that are already oxidized. It is recommended particularly for annealing fine wire of the non-ferrous type and for annealing wire products formed from such wire. Since the Brandt furnace anneals by a principle which causes penetration of the heat to the heart of the section being annealed, wire may be readily annealed in coils, the quality of the annealing and the condition of the surface being uniform from end to end of the coil. Hard and soft soldering are performed with equal facility, but since the difference in expense is simply a difference in the cost of the solder, hard soldering or brazing is very largely substituted for soft by users of the Brandt furnace. It is expected that savings in annealing and soldering costs will permit of the production of many new wire products hitherto considered commercially impractical. Production is a continuous straight line operation that requires no skilled operators. The equipment occupies a space seven feet long by three feet wide.

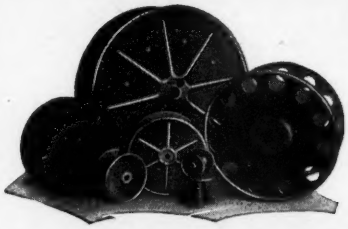
New Cable Cutter

OF particular interest to the cable industry is the new method of cutting cable now being introduced by the Morse-Starrett Products Company, 1916 Broadway, Oakland, Cal. The Company is marketing the Starrett Steel Bands and Cable Cutters—a line of tools which both whip and cut in the same operation any size cable up to one inch—taking one man less than a minute. The Starrett Band consists of a thin sheet of pliable but very tough steel indented at one end with a groove and lock seam. This is bent around the cable and locked in 20 seconds. The section of the cable enclosed by the band is then placed in the cable cutter and quickly severed, leaving the steel band on both cut ends.

The peculiar design of the cutter blade and die—an exclusive, patented feature—retains the natural shape of the cable and does not disturb the lay of the strands. The band, after cutting, furnishes an exceptionally clean whip or seizing for easy handling of the cable or in threading-through fixtures. The shape of the die also holds the cable firmly in place while cutting, enabling one man to handle the complete operation quickly and without assistance.

The device is proving very successful among users of cable because of its speed, safety and convenience for shop and field work. An increasing number of manufacturers and jobbers are also using the device and are sending their cable out to customers already whipped with the Starrett Band.

Included in the Starrett line of cutters are two sledge-type models and one lever type model. The bands are supplied in sizes to fit any size cable up to 1½ inches. The lever type cutter is especially designed for factory and warehouse use. Working on the ratchet principle is permits cutting with from three to seven strokes as the operator desires. It is extremely compact, the dimensions without the lever being: 13¼x12¼x7 inches.



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Name .....

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Semi-Continuous Wire Drawing Equipment Shows Saving Over Single Blocks

(*Continued from page 261*)

Savings

Table E summarizes fixed and variable costs by each method. The savings shown are conservative and represent a net return on the investment because the single block were ordinarily operated only one shift per day and not on the 3-shift basis assumed in these costs, because depreciation is on a 20-year life rather than a 15-year life as the Type B machines are, and because the investment is based on 1904 costs rather than replacement costs as of today.

The difference in fixed costs is $.1219, favorable to the old method, but the difference in variable costs, favorable to the Morgan-Connor machines, is $1.2464, making a net saving of $1.1245 per 1000 lb. and a reduction of 30% in cost. In a full year at the rate of production carried on in the three months studied the total saving is $7,103.22. This is a net return of 48% on the investment in machines and auxiliary equipment.

Quality

The quality of the wire has been improved. Formerly much of the wire produced varied .0015 in. from true gage. A check on twenty random bundles from the Type B machines showed a maximum variation of only .0007 in. The wire is also smoother and freer from scratches, apparently due to the fact that the twist put in the wire by the Morgan-Connor machines wears the die evenly on all sides. This is partly because there is less opportunity for the wire to tangle as it comes from the reels. Formerly an excess of wire was stripped from intermediate single blocks because of excessive breakage but now no more is taken from them than can be easily utilized.

A cleaning solution with longer life

IN a certain wire mill, the results of cleaning after forming were unsatisfactory. Moreover, it was necessary to drain the cleaning tank and renew the solution frequently. Production was interrupted, and cleaning costs were high.

At the request of the mill superintendent an Oakite Service Man was called in and made up the tank with a solution of an Oakite material.

With small periodical replacements, to keep the solution at full strength, this Oakite cleaning tank has operated for more than ten months with full effectiveness. Furthermore, reports indicate that wire cleaned the Oakite way makes possible greatly improved tinning.

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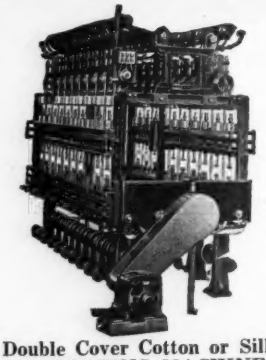

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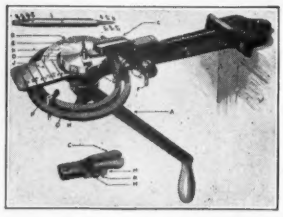

Patented April 2, 1918
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Originators of forms, "Evidence of Conception."

Scrap

Scrap amounts to approximately .380 lb. per 1000 lb. good wire produced. The average for single-block drawing on all sizes of wire from March 1 to May 31, 1927 was 2.98 lb. per 1000 lb. good wire produced.

Floor Space

The Type B machines require 67 sq. ft. to produce 1000 lb. wire in 24 hours. The single blocks required 105 sq. ft. for the same rate of production. The floor space reduction is 35.2%.

Safety

Accidents are carefully recorded in this plant. Two accidents have occurred on the Type B machine since they were put in operation. One man was struck in the cheek with a piece of wire, and another got a steel sliver in his arm. In neither accident was there any time lost. Over approximately 29,328 operating hours since these machines have been in operation, 2 shifts have been lost due to accidents or 6.82 shifts per 100,000 hours worked. The wire mill as a whole lost 28.3 shifts per 100,000 hours worked for the first 5 months of 1927. The safety features of the Morgan-Connor machines are freedom from loose loops of wire in the operating space, absence of high-speed reels from the operating floor, enclosure of all gearing and control equipment, and the arrangement of the operating lever which cannot be removed from the machine and does not interfere with work.

Methodical Handling

Handling of production with the Morgan-Connor machines is simpler because the material passes regularly through the machine from one end to the other. Finished wire and rods are separated and there is no storage of partially completed wire since no wire is stripped off until the bundle is complete. Cost keeping is also simpler than on single blocks.

Standard Specifications For Wires and Cables

(*Continued from page 266*)

5. Adhesion

The braid must adhere to the conductor sufficiently to prevent its removal from the conductor in an uninjured, unbroken condition for lengths greater than 3 in. except when special methods or appliances are used for the purpose.

6. Fire Proofing

All braids of slow-burning wires must be thoroughly filled with a non-conducting, fire-proofiing compunod to preserve the fibre and secure a covering which is slow-burning. The outer braids must be thoroughly slicked down and polished with a hard smooth surface.

7. Flame Proofing Test

The wire (after seasoning) must not convey fire nor support combustion for more than one minute after five fifteen-second applications of a standard test flame, the period between applications of test flame being 15 seconds. The flame used is a blue flame (about 5 in. (12.77 cm.) in height) obtained with a ½ inch (1.27 cm) Bunsen burner fed with ordinary illuminating gas at normal pressure. Previous to the test the burner and the gas supply line are adjusted to give a flame of the character described above. The sample is about 18 inches (46 cm.) long and is rigidly suspended vertically, by means of a clamp attached to a ring stand, in a room from which all drafts of air are excluded.

Th hot part of the "tip" of the test flame (i. e. the part above the blue cone in the flame) is applied nearly parallel to the suspended sample at a point about 3 or 4 inches (7.5 to 10 cm.) above its lower end. The flame is applied to the sample for 15 seconds and then removed and after a 15 seconds interval (whether the flaming on

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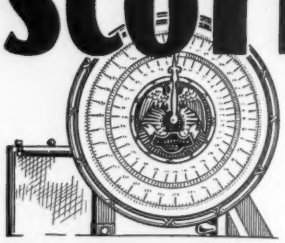

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the sample has ceased or not) the test flame is again applied at the same portion of the sample for 15 seconds and removed and the above operations repeated until the test flame has been applied at the same portion of the sample for five times.

During the test as well as after the fifth application of the test flame observation is made to determine whether or not the area of the sample supporting the flame extends outside the area exposed to the heat of the test flame (the effect of the heat of the test flame is considered as extending an inch or so beyond the "tip" of the test flame). Behavior and duration of flaming on the sample after the fifth application of the test flame are also noted.

The area of the sample supporting combustion shall not extend outside of the area exposed to the heat of the test flame, and the average duration of flaming after the fifth application of the test flame shall not exceed sixty seconds.

8. Test on Copper Conductors

The specifications for copper wire shall be those of the American Society for Testing Materials (to be superseded by any changes later adopted by the American Standards Association).

9. Samples for Test

The tests herein described shall be made upon fair samples, obtained after cutting back at least 2 feet (60 cm.) from the end of the reel or coil as shipped.

Explanatory Notes

Note 1. There are many types of heat resisting materials used for insulating electrical conductors, but no attempt is made in this specification to cover anything but the so called "slow burning" insulation. The various types of asbestos covering and enamels are for special purposes and are generally put out under trade names.

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551 Fifth Avenue
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Lift Trucks and Separate Bodies Speed Up Wire Production

(*Continued from page 267*)

other point in the plant.

Owing to the fact that nichrome scrap is quite valuable, all refuse from the foundry and cleaning department is put through a washing process for reclaiming the metal. For this process, box bodies are placed at suitable points. When full, the truck comes along, picks up the body and takes it over to the scrap yard in which is located the shed containing the washing machine. Here the load is either dumped directly into the machine or on the floor to be shoveled into the washing machine later.

At the street entrance to the cleaning room, a very useful berth or slip has been made, which just accomodates a body. When not loaded, it acts as part of the floor of the room. When a batch of material is ready to be sent from the cleaning room, it is washed, weighed, inspected and placed on the body, as shown in the photograph.

When completely loaded, the door is raised, the truck picks the body up and take it to its destination, returning later with an empty one to put in its place.

Almost immediately, following the installation of the first truck, it was found that three men could be released from the tasks they were doing, for more productive work. With still greater economies to be effected when the changes referred to above, are complete, it is estimated that the equipment will more than pay for itself within a year.

It is impossible, in the brief outline given above, to show clearly how much thought was given to the installation of this truck. Unlike the conditions existing in most plants where the activities of electric industrial truck are confined within the building or yards of the plant itself, those at the Driver-Harris Plant call for a truck of unusual construction. This plant

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occupies portions of several city blocks, and it is therefore necessary for the truck to pull through snow and mud over all sorts of roadways in the vicinity of the works, from one building to another. For that reason the load-carrying portion of the truck is mounted on springs.

An interesting instance of this truck's power as well as that of its Exide-Ironclad Battery, was offered recently when a large dump truck was sent with a load of refuse to the Driver-Harris dump. This was just about the time that the frost was coming out of the ground. Consequently, the big dump truck soon became mired. Another big truck was sent to pull it out, and this truck too, became stuck in the mud. The industrial truck was then called upon, and pulled out each of the two big gas trucks. Obviously, the industrial truck with its ability to haul such heavy loads under such adverse conditions, may be depended upon to overcome the ordinary obstacles likely to be encountered within the average plant.

Metal Interests Attend Hearings on Tariff Bill

(*Continued from page 259*)

ent years has merely served to prove the correctness of this opinion. The undeveloped resources of the United States in tungsten are enormous; and ample to supply its entire requirements.

"But it is not possible, in the long run, to produce tungsten profitably, without tariff protection sufficient to keep out the coolie-produced alluvial tungsten from China, and enable the domestic producer to obtain about $15 per unit. In our opinion, nothing less than an increase of 50 per cent in the existing tariff rate will effect this."

In paragraph 302, the House increased the duty on tungsten ore from 45 to 50 cents a pound.

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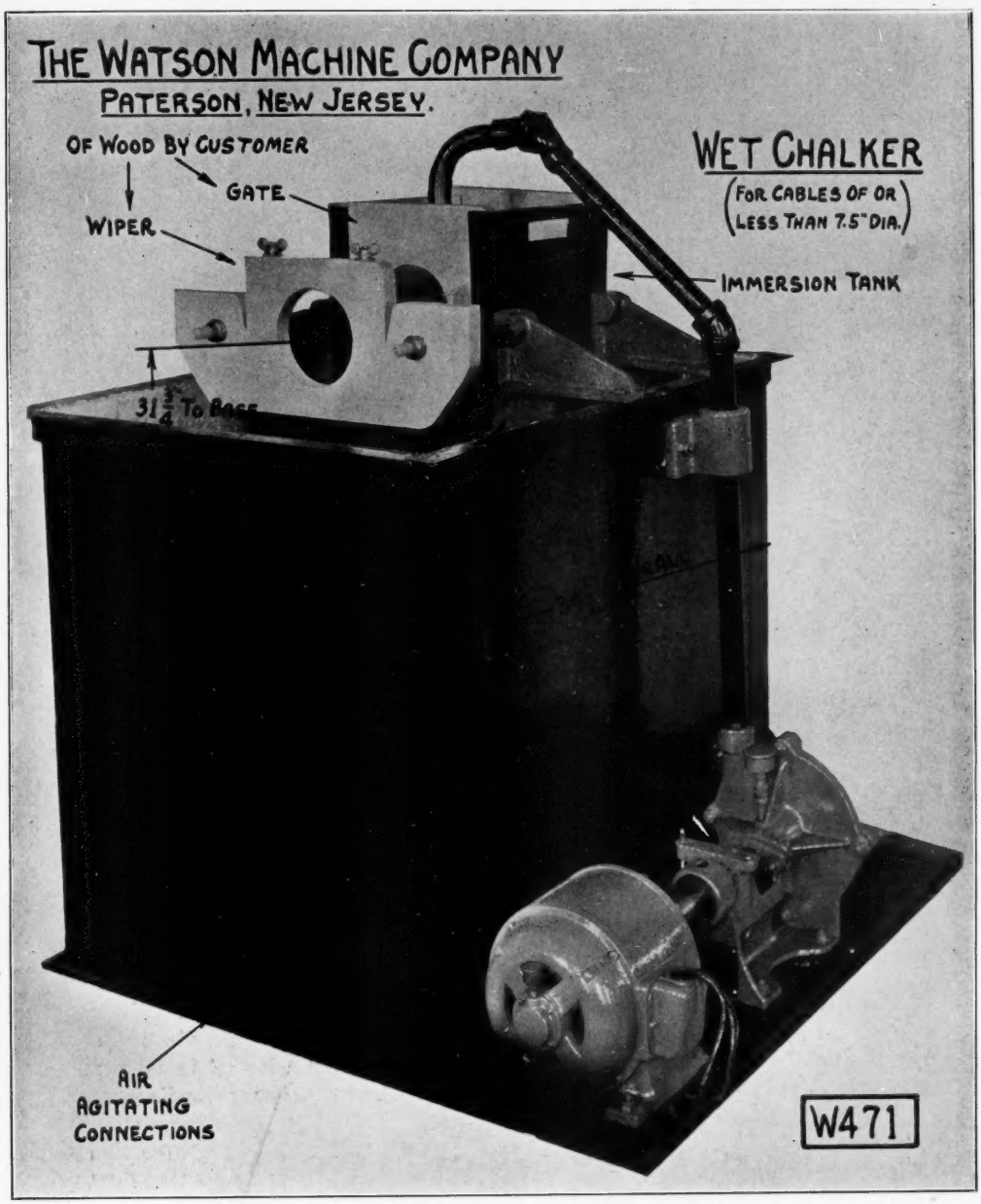

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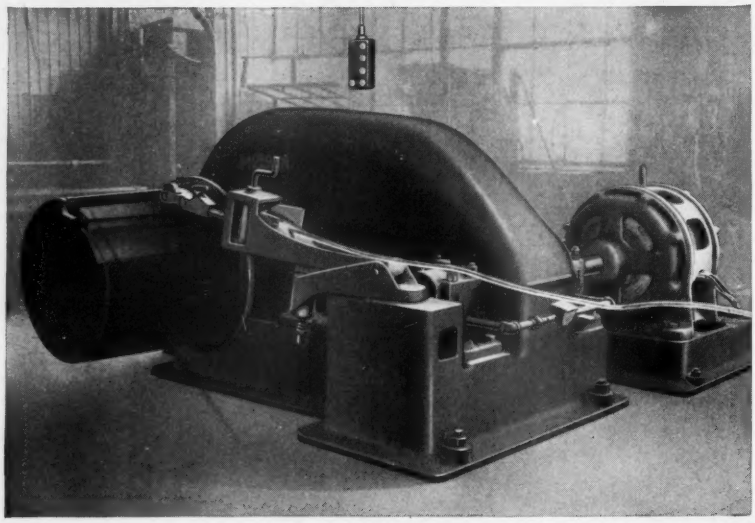

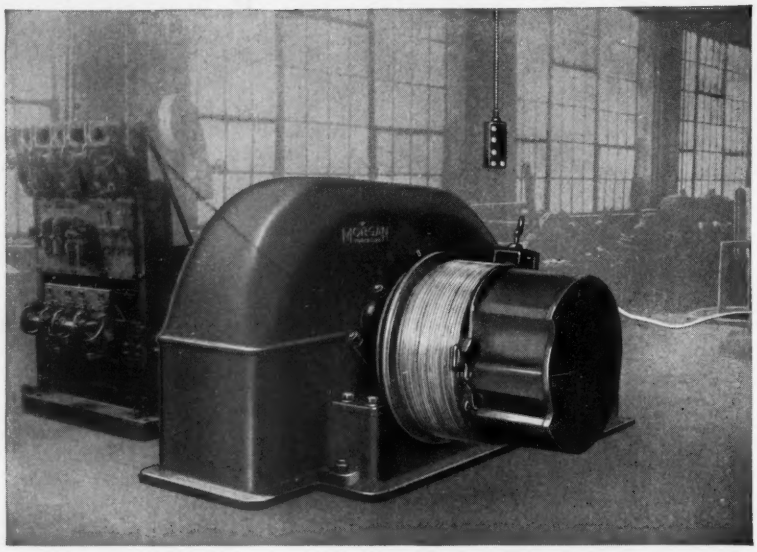

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Morgan Construction Co., Worcester, Mass.

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